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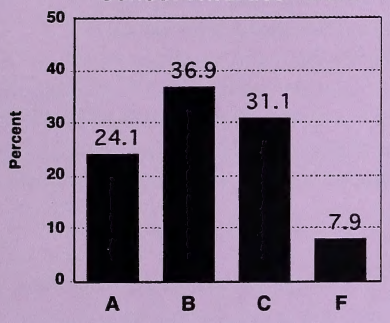
Chemistry 30

Diploma Examination Results
Examiners' Report for January 1994

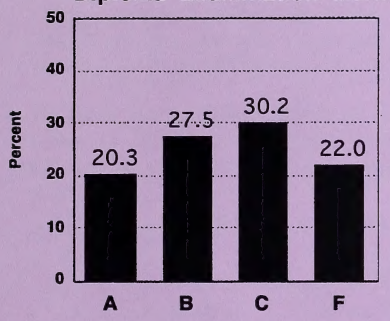
CANADIANA

AUG 9 1995

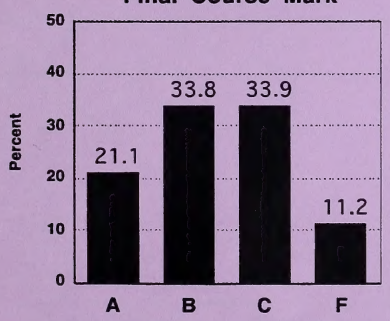
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1994 administration of the Chemistry 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Chemistry 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of three questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 7 097 students in Alberta who wrote the January 1994 examination. This represents a decrease of 976 compared to January 1993. The decrease is partially accounted for by the fact that 719 students received final course marks in the revised (pilot) Chemistry 30 course.

- 88.8% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 21.1% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Chemistry 30 was acceptable, particularly in knowledge of core concepts. However, students continued to have difficulty with laboratory-related skills and processes, and in organizing and communicating their chemistry knowledge.

Approximately 52.2% of the students who wrote this examination were female, which is similar to the normal percentage of females in the general population at this age group. There was no difference between the percentage of females and males in attaining the acceptable standard on the examination (78.0%).

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Student Evaluation

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Provincial Averages

- The average school-awarded mark was 68.2%.
- The average diploma examination mark was 63.4%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 66.3%.

Approximately 16.9% of the students who wrote the examination in January 1994 and received a school-awarded mark had written at least one other Chemistry 30 Diploma Examination during the June 1992 to August 1993 period. This subpopulation (1 198) achieved similar results (63.1%) to the population (5 899) whose first writing of a Chemistry 30 examination (63.4%) was in January 1994. However, the group of students who rewrote the chemistry examination increased their score, on average, from 51.2% to 63.1%.

Results and Examiners' Comments

Subtest

When analyzing detailed examination results, please bear in mind that subtest results cannot be directly compared.

Results are in average raw scores.

Machine scored: 34.5 out of 49

Course Content

- Chemical Energetics 10.8 out of 15
- Acids and Bases: 12.5 out of 18
- Oxidation-Reduction: 11.3 out of 16

Cognitive Levels

- Knowledge: 16.1 out of 20
- Comprehension and Application: 14.0 out of 21
- Higher Mental Activities: 4.4 out of 8

Written Response: 9.8 out of 21

Process Skills: 20.4 out of 33

Machine-Scored Blueprint (Multiple Choice & Numerical Response)

Each question in this section is classified in two ways: according to the curricular content area being tested and according to the cognitive level demanded by the question. The examination blueprint illustrates the distribution of questions in January 1994 according to these classifications. In the machine-scored columns, numbers without parentheses are multiple-choice questions and those in parentheses ( ) are numerical-response questions.

	Machine Scored			
Course Content	**Knowledge**	**Comprehension and Application**	**Higher Mental Activities**	**Examination Emphasis (%)**
Chemical Energetics	1, 2, 3, 4, 7, 8, 9	6, 10, 11, 12, 13, (1), (2)	5	21
Acids and Bases	14, 16, 17, 19, 21, 25, 27	18, 20, 22, 24, 23, 28, (3), (4)	15, 26, (5)	26
Oxidation-Reduction	30, 31, 33, 36, 41, 42	34, 35, 37, 39, (6), (7)	29, 32, 38, 40	23
Examination Emphasis (%)	29	30	11	70

Note: In the tables above, those questions which involve the use of science process skills from the multiple-choice section of the examination are 1, 4, 5, 6, 7, 10, 11, 15, 22, 23, 26, 28, 29, 34, 35, and 39; those from the numerical-response section are 1, 2, and 6; those from the written-response section are 1 and 2.

Science process skills received an exam emphasis of 47%.

Cognitive levels received a total examination emphasis of

- Knowledge 29%
- Comprehension and Application 51%
- Higher Mental Activities 20%

Teacher-Scored Blueprint (Written Response)

Each question in this section is designed to measure student achievement of two or more course objectives. Furthermore, students are expected to use a variety of cognitive skills to construct satisfactory responses. The examination blueprint illustrates the distribution of questions in January 1994 according to these classifications.

Question Number	Teacher Scored Question Description	Mark Value
1	Predicting the outcomes of the combustion of a common fuel. Applying and interpreting results to justify a selection. Communicating clearly and logically.	11
2	Determining the purity of a common substance and providing explanations for the impurities and the properties of the impurities. Communicating clearly and logically.	9
3	Comparing electrochemical and electrolytic cells from a chemical and practical application basis. Communicating clearly and logically.	10
Examination Emphasis (%)		30

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable level will obtain a mark of 50% and students capable of achieving the level of excellence will obtain a mark of 80%. Future examinations will continue to require students to demonstrate clarity in their thinking and an understanding of concepts by applying their knowledge to new and novel situations. Students who achieved these expectations were successful on this examination. All future diploma examinations will continue to require students to present their answers in a clear, concise, and organized fashion.

Multiple Choice

Question	Key	Difficulty*	Question	Key	Difficulty	Question	Key	Difficulty
1	A	81.0	15	B	73.9	29	B	54.4
2	C	74.0	16	A	82.9	30	B	72.9
3	D	71.9	17	C	80.8	31	A	91.0
4	A	91.3	18	C	67.8	32	D	71.5
5	C	52.7	19	B	89.9	33	B	94.4
6	D	79.6	20	C	70.9	34	D	85.6
7	A	49.8	21	D	59.8	35	C	76.0
8	B	83.7	22	A	91.7	36	A	81.6
9	A	91.2	23	C	84.1	37	D	51.5
10	C	90.4	24	D	69.3	38	B	70.7
11	D	77.5	25	C	90.8	39	B	62.2
12	B	43.1	26	C	41.8	40	A	62.6
13	A	50.5	27	D	84.8	41	D	65.3
14	A	97.2	28	D	47.1	42	D	78.0

*Difficulty—percentage of students answering the question correctly

The following two questions were selected for discussion because they exemplify what is required to meet the acceptable standard and the standard of excellence.

Use the following information to answer question 13.

$CH_3COCH_{3(l)} + 4\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + 3\,H_2O_{(l)} \quad \Delta H = -1791.0$ kJ

13. The energy change when 1.00 g of $CH_3COCH_{3(l)}$ reacts is

- •A. 30.8 kJ which is released to the surroundings
- B. 30.8 kJ which is absorbed by the reaction
- C. 1791.0 kJ which is released to the surroundings
- D. 1791.0 kJ which is absorbed by the reaction

Question 13: Most students (84.5%) were able to determine that a reaction would be exothermic and, as a result, would release energy to the surroundings. However, only 58.5% of all the students recognized that the heat released by one gram of a substance is not the same as the amount of energy released by one mole of the compound. Only 50.5% of the students could combine these two concepts correctly. The majority of students who achieved the standard of excellence (90.9%) were able to do this, but students who achieved the acceptable standard had very limited success (49.4%), and students who did not achieve the acceptable standard had very poor success (16.0%) on this question.

The results for this question suggest that students who do not achieve the acceptable standard do not understand fundamental concepts such as endothermic/exothermic changes and do not relate these concepts stoichiometrically.

20. The pH of a 4.0×10^{-2} mol/L monoprotic acid solution was measured and found to be 2.10. For this acid, the per cent dissociation with water is

- •A. 0.79%
- B. 4.0%
- C. 20%
- D. 80%

Question 20: Given the initial concentration and the pH of the solution, most students (70.9%) could successfully determine the percent dissociation of an acid. The most common mistake made by students (12.5%) was in using the algorithm for percent error of an experiment in solving the question. Another 9.2% of the students elected to ignore the pH and used only the concentration of the acid in their calculation. The majority of students who achieved the acceptable standard (73.6%) or better (97.6%) had success on this question, but students who did not achieve the acceptable standard had limited success (39.1%). This result suggests that students who achieve the acceptable standard are able to perform routine acid-base stoichiometric calculations but students who do not achieve the acceptable standard have difficulty with routine calculations.

Numerical Response

Virtually all students correctly followed the instructions for filling in the answer sheet. Students who did not round their answers as instructed lost marks.

Question	Answer	Difficulty*
1	1.25	67.1
2	2.19	74.0
3	1465	54.8
4	2.39-2.37	50.3
5	90.9	9.3
6	7531	75.8
7	21.6	32.5

*Difficulty—percentage of students amswering the question correctly

6. The oxidation number of chlorine in each of the ions ClO_4^-, ClO_3^-, ClO_2^-, ClO^-, is respectively____, ____, ____, ____.

Question 6: The average for question 6 was 75.8%. This question discriminated well between weak and average students. Virtually all students who achieved the standard of excellence (96.5%) were successful. The majority of the students who achieved the acceptable standard (78.0%) were able to correctly assign oxidation numbers to four polyatomic ions. Only 33.5% of the students who did not achieve the acceptable standard were able to do this. The most common mistake students made (9.0%) was in neglecting the charge on the ions; the only other mistake identified (3.9%) was in using the number of oxygen "atoms" present in the ion as the oxidation number. This suggests that students achieving the acceptable standard do so because they can assign oxidation numbers to polyatomic ions.

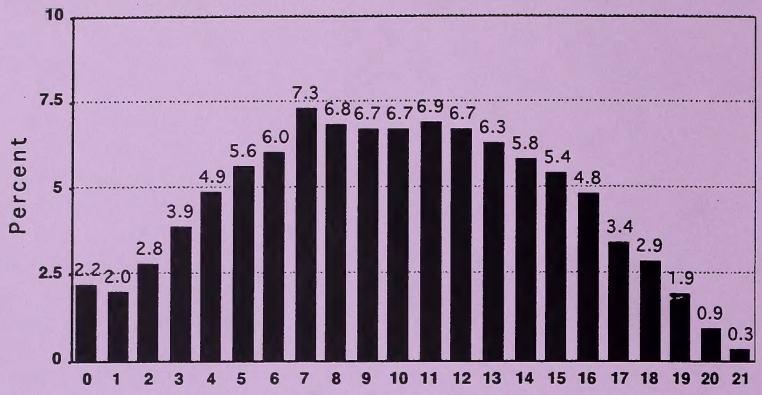
7. An electrochemical cell, $Zn_{(s)} / Zn^{2+}_{(aq)} // Ag^{+}_{(aq)} / Ag_{(s)}$, is constructed using zinc and silver electrodes. If the anode mass changes by 6.54 g, then the predicted mass change for the cathode is _____g. (Record your answer to three digits.)

Question 7: The average for question 7 was 32.5%. This question discriminated very well between students who achieved the standard of excellence and those who did not. The question involved the determination of the mass change of a cathode given the change in mass of the anode and the cell notation for the electrochemical cell. Although 4.5% of all the students did not attempt this problem, virtually all of the students achieving the standard of excellence did and 70.6% of these were successful. Very few of the students who only achieved the acceptable standard (26.5%) and virtually no one who did not achieve the acceptable standard (2.4%) were successful in solving this question. The most common mistake made were in using the concept of conservation of mass and in not recognizing that the dissolved ions are part of the system. As a result, 25.0% of the students reported that the mass change of the cathode was identical to the mass change of the cathode, another 8.1% used this logic but recognized that there was a 2:1 ratio involved. Another common mistake made by 3.9% of students involved using the correct algorithms for the solving the question but omitting the 2:1 ratio between the $Zn_{(s)}$ and the $Ag^{+}_{(aq)}$.

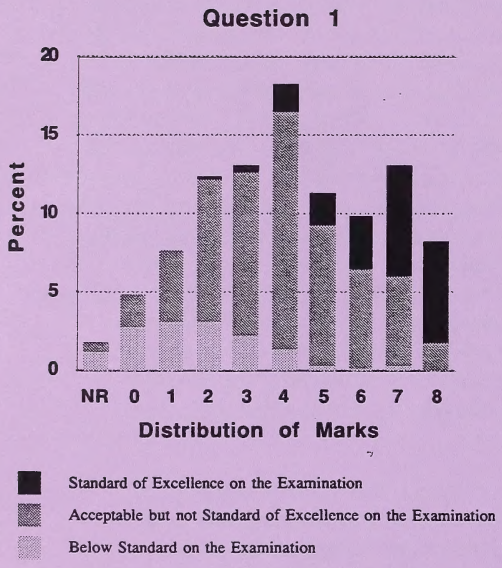
The results for this question suggest that students achieving the standard of excellence do so because they combine tasks such as extracting relevant information from standard cell notation, identifying the reagents involved in the reaction, and performing valid calculations.

Written Response

The level of achievement on the written-response section was less than expected: less than half of the students (45.3%) achieved a mark of 11 or higher out of 21. The average mark on the written-response section was 9.82 (46.8%) of the available marks.



Distribution of Marks for Written Response



Question 1 was answered as well as was expected. It should be noted that the intent of this question was to distinguish between students below the acceptable standard and those at the acceptable standard. Students who failed to achieve the acceptable standard on the examination were expected to score either 1 or 2 on this question. By writing unbalanced chemical equations, and by successfully calculating a molar heat of reaction for their equation, they averaged 1.67 marks The most common mistakes this group made were failing to convert molar heat into heat per gram, not balancing their chemical equation, and making a selection based on dissimilar information. Most of these students were able to select a fuel to use on a winter camping trip. They had difficulty in interpreting the graph provided in order to explain why the fuel they selected was a better choice.

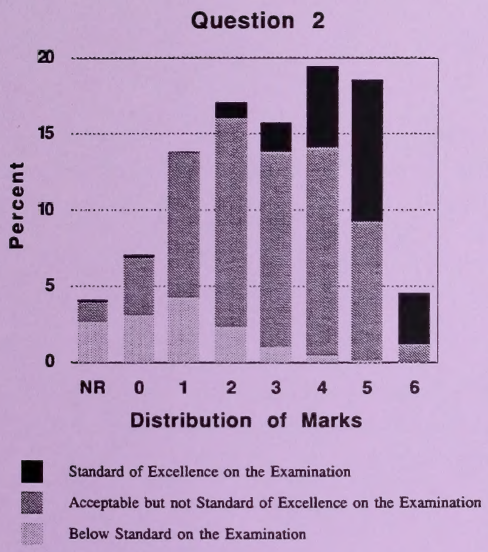
Students who attained only the acceptable standard were expected to score 3, 4, or 5 on this question. By writing a balanced chemical equation for the combustion of butane and correctly performing the stoichiometric process for determining the molar enthalpy, they averaged 3.88 marks. They paid careful attention to rounding off to the proper number of significant digits and to the use of units throughout. They had difficulty in determining the energy released per gram of fuel, but they were able to interpret the graph and select a fuel. However, their explanations were confused, due in part to their inability to compare similar measures of energy. They tended to compare the energy released by one gram of propane to the energy released by one mole of butane. As a result, they tended to offer valid statements which were contradictory in nature, which resulted in ambiguous answers.

Students who achieved the standard of excellence were expected to score 7 or 8 marks and they did. By writing the correct equation and performing the necessary calculations, they averaged 6.58. They selected a suitable and practical fuel for winter camping and were able utilize information from their calculations and the graph to support their decision. Their responses were well organized and their ideas

were communicated clearly with essentially no communication errors. The mistake that prevented them from achieving full marks was in presenting an implicit argument. For example, they assumed that when they referred to low temperatures, a reader would assume that they meant temperatures less than –12°C.

The results on this question suggest that all students achieving the acceptable standard can perform Hess's Law calculations, draw conclusions from their own calculations, and use graphical information, but that they have difficulty in expressing answers in nonroutine units, such as kJ/g.

On this 8-mark question, the average mark was 4.14 for 51.8% of the available mark.



Question 2 was answered as well as was expected. Students who did not achieve the acceptable standard were expected to score 0 or 1. They averaged 1.03 by attempting part C of the question. They were able to suggest a reason for the addition of a filler to an HASA tablet but were unable to provide appropriate properties of the filler. They had difficulty in writing a balanced net ionic equation and could not determine the mass of HASA in the tablet, nor did they display any knowledge of how to determine percent purity. Most of these students displayed very poor mathematical skills and their responses were poorly organized and communicated. Spelling, grammatical, significant digit, and unit errors were the norm in their responses.

Students who achieved the acceptable standard on the examination were expected to score around 3. They averaged 2.80 by correctly determining a method to find the mass of HASA in the tablet. However, most students assumed the tablet was pure and determined the percent error of the experiment, rather than the percent purity of the tablet. Generally, they provided lots of inaccurate and inappropriate "verbal filler" about the properties of the filler. The majority of the responses showed evidence of a good understanding of significant digits and units.

Students who achieved the standard of excellence were expected to score 5 or 6. They averaged 4.56 by clearly communicating their answers. They had no difficulty in determining the relationship required to determine the percent purity of the tablet, nor did they have any difficulty in giving a reason for the presence of a filler and giving several properties for the filler. The most common mistake this group made was in assuming that the filler should neutralize the acid before the tablet was swallowed. Most responses showed good communication and organizational skills.

The results on this question suggest that all students achieving the acceptable standard can perform common acid-base stoichiometry but have difficulty in handling nonroutine problems, such as percent purity.

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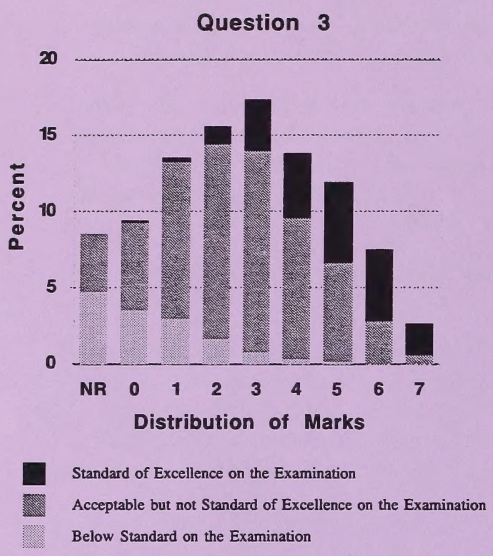

On this 6-mark question, the average mark was 2.91 or 48.5% of the available mark.

Question 3 was not answered as well as was expected. Students who did not meet the acceptable standard were unable to correctly address the question and scored, on average, 0.72. These students were able to give an application for one of the cells and recognized that one type of cell involved spontaneous reactions while the other did not. Unfortunately, these students were unable to identify which cell involved spontaneous reactions or to progress further into the question. These students had difficulty expressing themselves and showed little indication that they understood what compare and contrast meant. As a result, markers had to interpret these students' responses which, in many cases, contained convention errors.

Students who achieved only the acceptable standard scored, on average, 2.56. They correctly identified several differences between the two cells and they could usually identify a practical use for each cell. However, most of these students could not identify any similarities between the cells nor could they address the design component of the question and, as a result, their answers tended to ramble on. These students were able to communicate their ideas well enough to the markers so that little, if any, interpretation was required.

Students who achieved the standard of excellence displayed good analytical and communication skills, and scored, on average 4.67, for this question. They answered all parts of the question well. The only area of weakness noted was in their description of the similarities of the two cell types. These students presented their answers in a concise, organized fashion and expressed themselves clearly to the markers so that no interpretation was required.

Most students had difficulty in organizing a response to a "compare and contrast" question and were troubled with the use and spelling of terms such as "separate" and "secondary cell." These problems resulted in a loss of communication/convention marks.

The result on this question suggest that all students, except those at the standard of excellence, could profit from more exposure to "compare and contrast" questions as well as from guidelines on how to organize their answers.

On this 7-mark question, the average mark was 2.73 or 39.0% of the available mark.

For further information, contact Don Loerke or Phill Campbell at the Student Evaluation Branch, 427-0010.